Economizer Control Using Mixed Air Enthalpy

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Outline

- Introduction
- Purpose
- Enthalpy(Humidity) Measurement
- Innovative Enthalpy Economizer Control
- Case study
- Conclusions

Introduction: Economizer

- Energy Saving Measures Recommended by ASHRAE
- Dry-Bulb Temperature Based Economizer and Enthalpy Based Economizer
- 5~50% More Energy Saving with enthalpy economizer compared to D.B. based economizer

Conventional enthalpy economizer control

- Switch to Economizer Cycle Based on Outside Air enthalpy
- Need to Measure Outdoor Air Humidity
- Issue : Outside air environment is too harsh for reliable humidity sensor performance

Not Applicable

Purpose

Q: How to make Differential Enthalpy Based Economizer work with current humidity sensor technology?

A: Innovative Control Algorithm using Mixed Air Enthalpy

Humidity Measurement: Considerations

Temperature Dependency

- RH% sensors need temperature compensation when not operating at their nominal value
- Narrower temperature range is better

Parameters	Outdoor air duct	Mixed air duct
Temperature range	-10~110°F	50~85°F

Humidity Measurement: Considerations

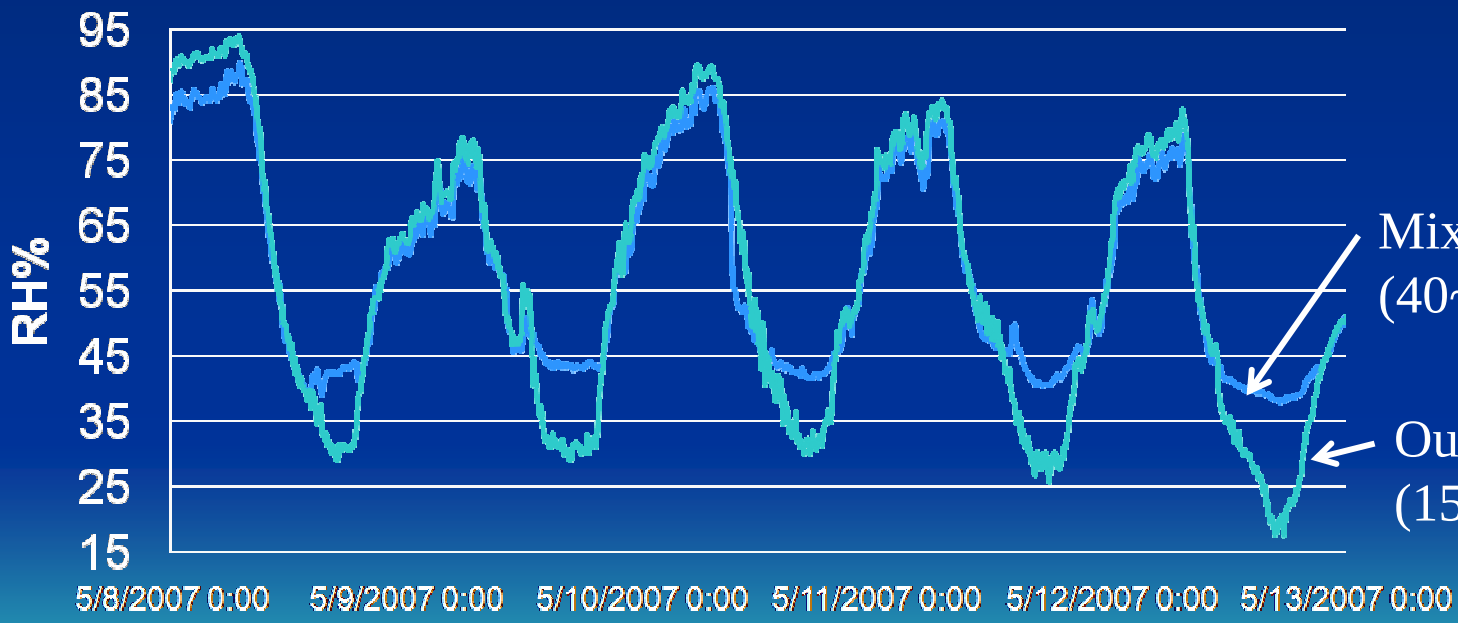
No single type of humidity sensor can cover entire humidity span (rain, fog, condensation)

- Capacitive RH%: Low accuracy in high humidity level
- Resistive RH% : Low accuracy in Low humidity level
- Saturated-Salt dew point: Not capable in low humidity level

Parameters		Outdoor air duct	Mixed air duct
Chance at high or low humidity level		More	Less
System On	Humidity range	0~100%	15~100%
	Air velocity	0~500 fpm	300~2000fpm
System Off	Humidity range	0~100%	20~90%
	Air velocity	0~20 fpm	0~50fpm

Humidity Measurement: Considerations

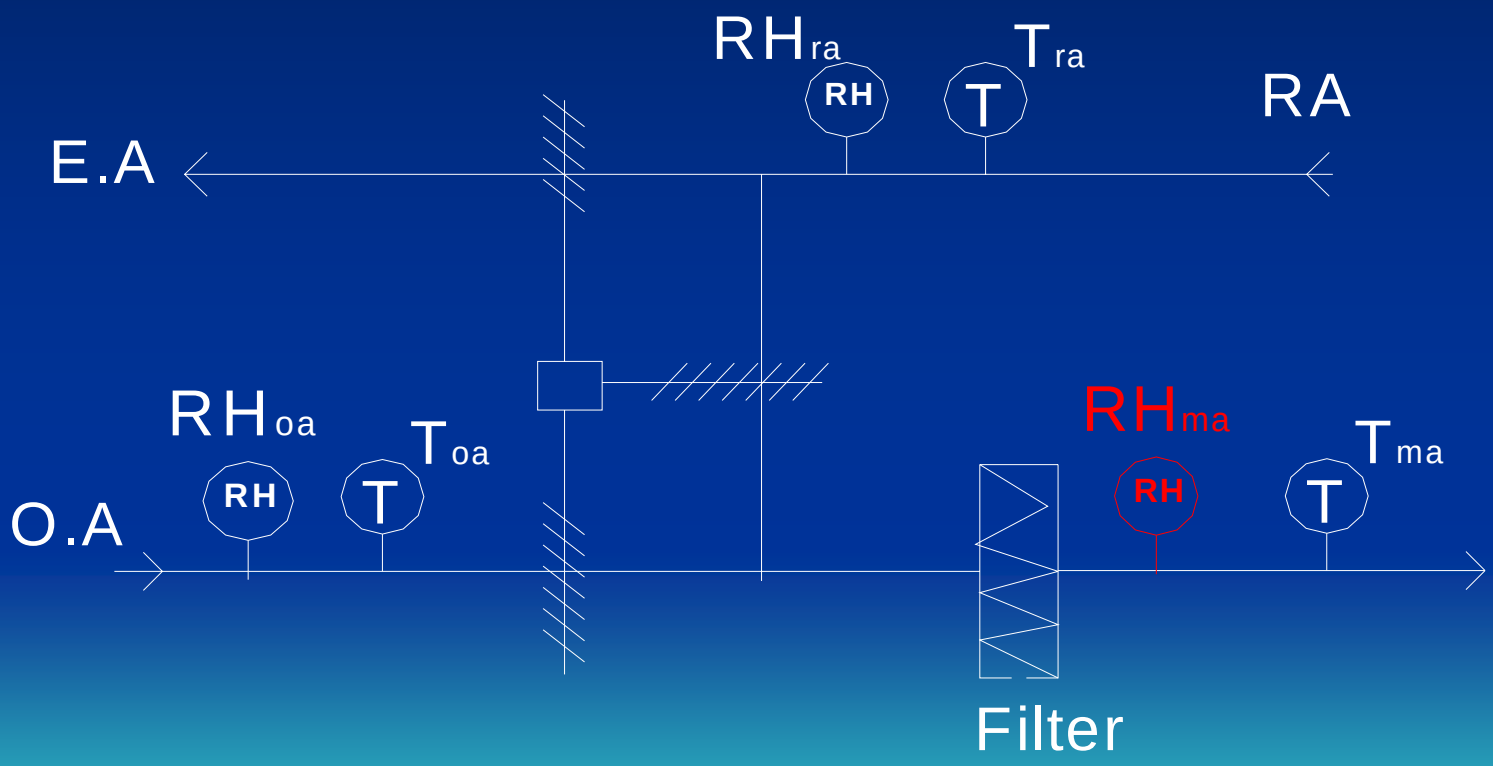
Large drift with wide humidity/temperature cycle



Humidity Measurement: Conclusion

Mixed air environment ensure more reliable humidity measurement

Innovative Enthalpy Economizer: System Upgrade



Innovative Enthalpy Economizer: Control Algorithm

Condition	Mode of operation
$h_{ma} > (h_r + 5\% \times h_r)$ or $T_{oa} > (T_{ra} + 5)$	Minimum outdoor air intake
$h_{ma} < h_r$ and $T_{oa} < (T_{ra} + 3)$, and $T_{oa} > T_{sa}$	Partial free cooling
$h_{ma} < h_r$ and $T_{oa} < (T_{ra} + 3)$,and $T_{oa} < T_{sa}$	Total free cooling

Case Study

Facility Information

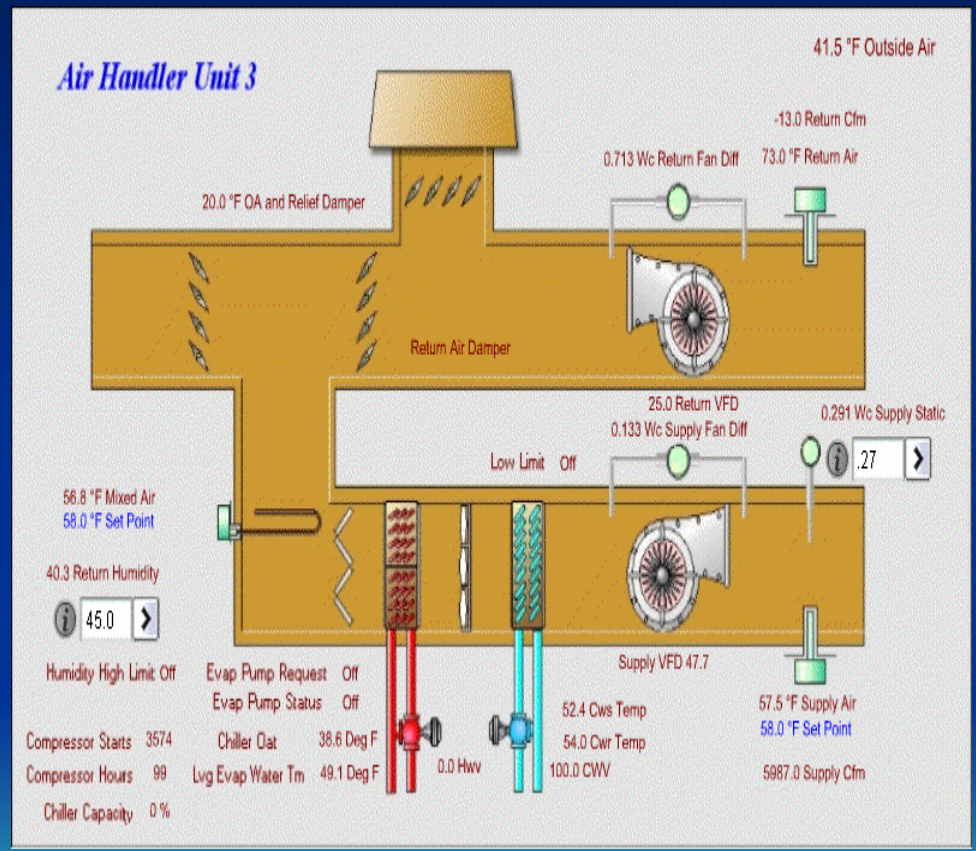
- Location: Omaha, NE
- Function: Hospital
- Area:25,000 ft^2

Case Study: experiment setup

- AHU1: Single duct VAV Systems
- Design air flow: 15000CFM
- Dry-Bulb based economizer with 65°F Switchover set point
- System Operation hour: 24/7

Case Study: experiment setup

- AHU3: Single duct VAV Systems
- Design air flow: 14000 CFM
- Mixed air enthalpy based economizer
- One RH% sensor is installed in outside air duct for comparison
- System Operation hour: 24/7



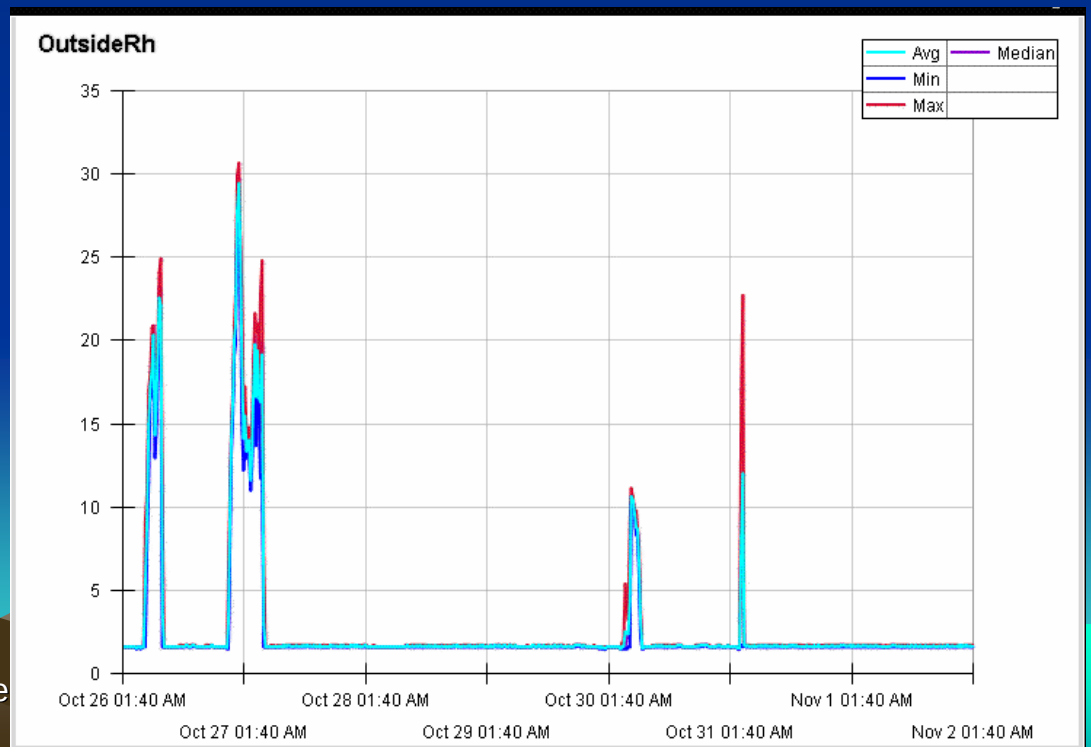
Sensor Information

Manufacture Data

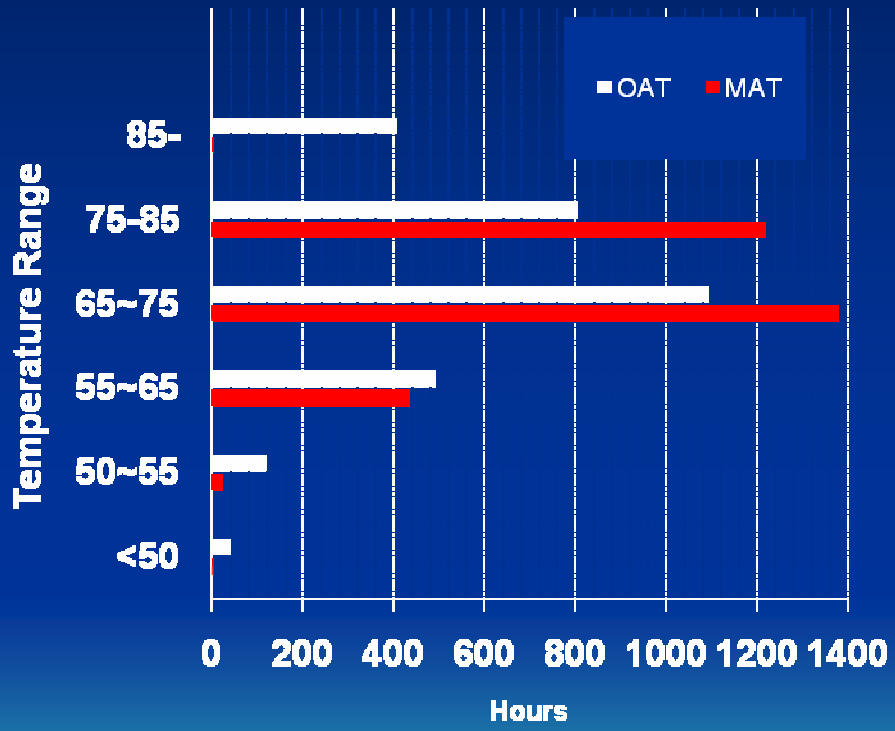
Sensing element	Resistance change of bulk polymer
Accuracy (at 77°F)	±3% (with 20~95%)
Temperature effect	0.06%per°F
Hysteresis	1%
Drift	1% per Year

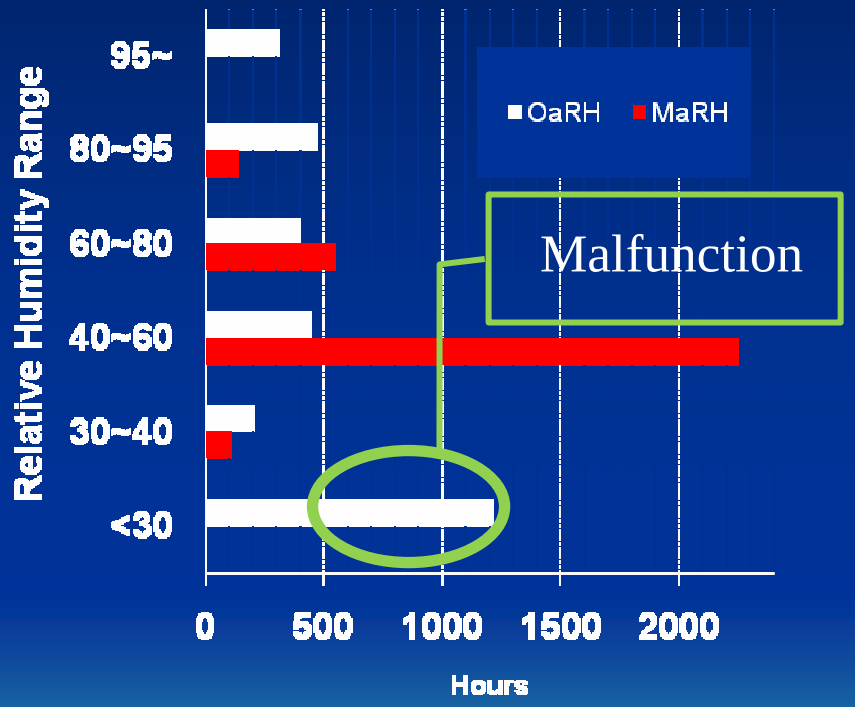
Sensor Operation:

Measured drift	In Mixed air Duct	After 4 months	**1.8%**
		After 7 months	**2%**
	In Outdoor air Duct	After 4 months	**3.5%**
		After 7 months	**Malfunction**



Mixed Air V.S Outside Air : Measured Temp. and RH%





D.B Temp. V.S Enthalpy Economizer

Testing Period: April.15th~Aug. 22th ,2007		
	Temperature-based Economizer	Mixed-air enthalpy economizer
Operation hours	688	1051
Annual Energy saving (by Simulation)	-	15.7%

Conclusions

- Air in mixed air duct is much more favorable than air in outdoor air duct in the aspect of humidity measurement
- Using mixed air enthalpy can achieve real enthalpy economizer
- Less maintenance needed with new enthalpy economizer control

Thanks!
Question?